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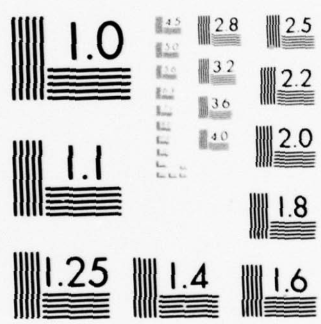


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PHYSICOCHEMICAL BASES OF THE USE OF HIGHLY DISPERSED AEROSOLS FOR DEALING WITH HARMFUL INSECTS

by

A. A. Koval'skiy, K. N. Kutsenogiy



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By: A. A. Koval'skiy, K. N. Kutsenogiy

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## U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

| Block | Italic | Transliteration | Block | Italic | Transliteration |
|---|---|---|---|---|---|
| А а | *А а* | A, a | Р р | *Р р* | R, r |
| Б б | *Б б* | B, b | С с | *С с* | S, s |
| В в | *В в* | V, v | Т т | *Т т* | T, t |
| Г г | *Г г* | G, g | У у | *У у* | U, u |
| Д д | *Д д* | D, d | Ф ф | *Ф ф* | F, f |
| Е е | *Е е* | Ye, ye; E, e* | Х х | *Х х* | Kh, kh |
| Ж ж | *Ж ж* | Zh, zh | Ц ц | *Ц ц* | Ts, ts |
| З з | *З з* | Z, z | Ч ч | *Ч ч* | Ch, ch |
| И и | *И и* | I, i | Ш ш | *Ш ш* | Sh, sh |
| Й й | *Й й* | Y, y | Щ щ | *Щ щ* | Shch, shch |
| К к | *К к* | K, k | Ъ ъ | *Ъ ъ* | " |
| Л л | *Л л* | L, l | Ы ы | *Ы ы* | Y, y |
| М м | *М м* | M, m | Ь ь | *Ь ь* | ' |
| Н н | *Н н* | N, n | Э э | *Э э* | E, e |
| О о | *О о* | O, o | Ю ю | *Ю ю* | Yu, yu |
| П п | *П п* | P, p | Я я | *Я я* | Ya, ya |

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

| Russian | English | Russian | English | Russian | English |
|---|---|---|---|---|---|
| sin | sin | sh | sinh | arc sh | $\sinh^{-1}$ |
| cos | cos | ch | cosh | arc ch | $\cosh^{-1}$ |
| tg | tan | th | tanh | arc th | $\tanh^{-1}$ |
| ctg | cot | cth | coth | arc cth | $\coth^{-1}$ |
| sec | sec | sch | sech | arc sch | $\operatorname{sech}^{-1}$ |
| cosec | csc | csch | csch | arc csch | $\operatorname{csch}^{-1}$ |

| Russian | English |
|---|---|
| rot | curl |
| lg | log |

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# PHYSICOCHEMICAL BASES OF THE USE OF HIGHLY DISPERSED AEROSOLS FOR DEALING WITH HARMFUL INSECTS.

A. A. Koval'skiy, K. N. Kutsenogiy

In article are analyzed the specific special feature/peculiarities of the application/use of highly dispersed aerosols in fight with harmful insects. Are shown the advantages of the use of a powerful cloud of highly dispersed aerosols. Is given explanation of the reasons for a decrease in the norm of the consumption of toxic chemical during the use of a powerful wave of highly dispersed aerosols. Is given the simplest pattern of the calculation of a change in the dose with distance and is carried out the comparison of calculation data with experiment. Is noted the satisfactory agreement between experimental data and calculation.

The chemical method of fight is at present basic with the

protection of plants from wreckers and diseases [1-3]. Soon, in the opinion Soviet and foreign specialists's majority, to this method will belong the leading place with the protection of agricultural and wood crops.

Not the always the judicious use of this method was led to a series of undesirable consequences; therefore along with the selection of toxic chemical, large value has a selection of the most rational method of its application. The greatest effectiveness with the smallest harmful consequences, the basic criteria, by which one should be guided under determination condition of optimum character. In the final analysis this is reduced to a decrease in the norm of the consumption of toxic chemical and the proper selection of torque/moment and duration of its action. Any residue/settling of toxic chemical on soil and the plants is undesirable, since it affects not defined for long.

For the determination of the possibility economical utilization of a toxic chemical, let us conduct the comparison of the fundamental characteristics of the existing methods of chemical fight with harmful insects. At present almost entire/all mass of the toxic chemicals, utilized in fight with harmful insects, is applied by the method of aerial dusting or aerial sprayings, also, to small degree in the form of aerosols. With aerial dusting and aerial spraying, the

particle sizes are relatively great (more than 100 μ), in the form of the aerosols of particle smaller. The large productivity of aerosol method, the possibility of the complete mechanization/high-lift device of work and the possibility of fight with the flying forms of insects are the sign/criteria which profitably differ this method as one of foremost. Is now narrower accumulated the considerable experimental material, which created durable basis for the practical use of this method [4-7]. Noting the advantages of aerosol method and indicating the which are inherent in this method shortcomings, the authors of the indicated work insufficiently fully revealed its other essential special feature/peculiarities.

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All the aerosol generators, utilized with the protection of plants from harmful insects, are distinguished, first of all, by the dispersed composition of those who are formed by them aerosols.

It is known that the generators, working on thermo-condensation principle, create the most highly dispersed aerosols. During the purely condensation formation/education of aerosols, the particle size composes ones of microns according to diameter. As a result of numerous experiments, it is establish/installed that the neutral dispersed composition of basic conditions/mode of MAG (powerful

aerosol generator) is such; from the total quantity of toxic chemical, transferred into aerosol state, 85o/o falls on particles by the diameter of less 5 $\mu$, to the drops of more than 25 $\mu$ - a total of 5o/o. These data show that in work of MAG on basic conditions/mode is formed predominantly condensation aerosol with the small impurity/admixture of the larger particles, which remained after the incomplete evaporation of drops, formed during the fragmentation of liquid by high-speed gas flow.

The recommended modes of the small thermomechanical generators, produced by industry, provide for along with condensation aerosol the considerable portion (to dozens of percent) of the unevaporated large particles. With the maximum consumption of work substance in generator AG-UD-2, impurity/admixture of such particles will be 10-50o/o of common/general/total mass. A basic difference in the highly dispersed aerosols is a low size/dimension of toxic particles.

We examine in greater detail, as this is exhibited during their use. First of all, the action of toxic particles can be revealed in two ways: or as a result of the direct grip/capture of them by insects at the moment of the passage of aerosol cloud (acute/sharp action), or as a result of the effect of the particles, deposited on the plants where dwell harmful insects (permanent action).

When treatment/working is conducted by the method of aerial spraying or aerial dusting, toxic particles have very large size/dimensions (usually more than 100 μ in diameter). This is led to the fact that less than the minute after the ejection of particle they reach the earth's surface or surface of plants, settling on the latter. With this method of treatment/working by basic, is the residual action, which is continued indefinitely long time. The characteristic for highly dispersed aerosols small particles of toxic chemical settle very slowly and hold in air long time. Their propagation is determined by the character of the turbulent pulsations of atmospheric boundary layer.

In real atmosphere because of the intense turbulent pulsations of the velocity vector of wind of particle by the diameter of less 20 μ do not virtually settle [4, page 249]. For a comparison recall that the particles by the diameter of less 0.2 μ accomplish because of the chaotic motion of molecules prolonged Brownian motion, barely settling even in completely still air. The highly dispersed aerosols, created thermo-condensation by the method, only by those having at present practical value, in real atmosphere represent virtually the not settling system. Hence it follows that basic during the application/use highly-disperse aerosols is the acute/sharp action, which is exhibited only during the stay of insect in aerosol cloud.

The result of effect depends on the concentration of aerosol particles and time of effect. It is customary to assume that the result of the effect of aerosols on insect is determined by dose, by this is understood the product of mean concentration and the retention time of insect in aerosol cloud (more accurately - integral of concentration of time). Thus, it is possible to obtain identical result, affecting by low concentration long time and by short-term high concentration.

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It is necessary only so that in both cases would be equal doses. The possibility of obtaining sufficient death of harmful insect with very low residue/remainders on vegetation of toxic substances is great advantage of highly dispersed aerosols, the giving essential improvement in the sanitary-hygienic conditions. Thus, for instance, forest, processed by aerial spraying or aerial dusting, approximately one month must be found in quarantine - is forbidden the pasturage of domestic cattle and the use of grasses. During the application/use of highly dispersed aerosols, the need for this is eliminated.

Moreover, under the acute/sharp effect appears supplementary possibility to avoid harmful consequences for useful entomological fauna, if the periods of the active activity of useful and harmful

insects do not coincide. Thus, highly dispersed aerosols have advantage from the viewpoint of minimum harmful consequences.

Treatment/working the forests has its specific character. The basic widely used method is aerial spraying. During this treatment/working settling particles occurs in essence on the upper part of the tree tops, on the upper part of the sheet surface. Therefore not always the effectiveness of this treatment/working is sufficiently high. Furthermore, the need for the coating almost of an entire surface of leaves is led due to large particle size to the large norms of the consumption of toxic chemical.

Thermomechanical type small aerosol generators, which form condensation aerosol with the impurity/admixture of large particles, for example AG-UD-2, have width of grip/capture of approximately 100 m. Therefore such machines cannot be applied in forest/scaffolding where the transient roads are located at a distance 1-2 km. The application/use of powerful generators, working in the same conditions/mode, as low, i.e., with the considerable portion of large particles, is inexpedient, since due to strong filtration in scaffolding/forest large particles rapidly will settle. At a distance in several kilometers from the trajectory of generator will be virtually spread the particles of condensation origin, i.e., by diameter several microns. Due to the low speed of the sedimentation

of such particles of the high effectiveness, it is possible to expect only with an increase of the dose into dozens and of hundreds of times [4, page 135-147]. Thus, prior to the beginning of the experimental production tests of MAG against wood wreckers were doubts of the prospect of such treatment/workings. The many-year experience of successful application/use of MAG against a series of dangerous wood wreckers showed the groundlessness of these fears. Highly dispersed aerosol cloud was sufficiently effective at distances to 5-7 km of the trajectory of generator [8, 9].

Thus, from analysis it is evident that a change in the dispersity changes the character of effect. With aerial spraying and aerial dusting they dealt with residual action, during the use of highly dispersed aerosols - with acute/sharp action. Aerosol method on the strength of the fact that the particles are located long time in suspension, makes it possible to carry out an effect and by high concentrations and low concentrations.

Let us examine the qualitative picture of the propagation of aerosol wave on the workable territory. When conducting of aerosol treatment/working generator, moving approximately perpendicular to wind direction, is created the wave, which by wind it is transferred on the assigned/prescribed territory, being eroded because of turbulent diffusion. Since generator moves with sufficiently high

speed, for short time it creates long wave (by length several kilometers).

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Blurring this extended wave along the trajectory of generator occurs only at edges, and in center section the concentration can be changed only because of blurring in vertical direction and in wind direction. If cloud was not eroded in vertical direction, then its blurring along wind direction would be led, on one hand, to a decrease in the concentration in cloud, with another - in equal measure to an increase in the time of effect. In this case the dose would not be changed with distance.

The basic factor, which determines a change in the dose, with distance, is the vertical blurring of cloud. This means that it is necessary the conditions of conducting the treatment/working to select so that the vertical blurring would be smallest. Therefore are most favorable the conditions of the inversions, which occur in the period between approach and sunrise. In the process of blurring cloud near the ground of atmosphere, its vertical size/dimension grows more slowly than distance from the trajectory of generator. With constant coefficient of turbulent diffusion and wind, as we shall see from further quantitative evaluations, an increase in the vertical

size/dimension is proportional to square root of the distance, passed by wave. If we now compare the distances at which the doses from two generators of different power will be identical, then it appears that for a more powerful generator this distance increases faster than grows its power. Physical sense of this in the nonlinear dependence of dose on distance.

In order to better understand the reason for a decrease in the norm of consumption, let us observe a change of the dose in powerful cloud, beginning from the distance where the dose from small generator fell to smallest possible value (to the value of the lethal dose).

It is obvious that from more powerful generator at a distance where from small generator we have lethal dose, dose will be more as much once, in as are distinguished the power of generators. Now let distance will increase so much once, in how often are distinguished the power of generators. If dose varied linearly with distance, then at new distance from powerful generator, dose would become equal lethal. But when the decrease of dose occurs more slowly, at new distance the dose from more powerful generator will be above lethal. It is clear that now from the powerful generator of lethal the dose will be at a distance which increases faster than an increase in the power of generator. For example, if vertical size/dimension increases

proportional to the square root of the distance, passed by wave, then for two generators, which differ in power two times, distances at which the doses have identical values, they will be distinguished four times. Since for a double more powerful generator (generator, which consumed during the creation of the cloud of identical extent double more toxic chemical) the unknown distance increased four times, the average norm of consumption (or the specific consumption of toxic chemical) decreases double. Thus, an increase in the power of aerosol generator is led to a reduction/descent in the average norm of consumption.

Than more powerful cloud, those nct larger distance/removal it remains effective in comparison with low. But at larger distance/removal from the line of the generaticn of aerosols cloud more is eroded in longitudinal wind direction, thereby increases the time cf effect. As a result of an increase in the time of effect, appears the possibility of the effective processing by smaller concentrations.

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Since there are no fundamental limitations for the power of aerosol generator, logically does arise question, are there factors, which set practical limitation on the maximum power of generator?

Beginning from 1961 in the Institute of chemical kinetics and burning of the AS USSR they are conducted the wide experimental production tests of powerful aerosol generator. During this period is processed the area about a million of hectares, mainly, forest. In the process of testing, the generator worked in this conditions/mode: the speed of motion of approximately 10 km/h; power of approximately 200 l/min of 10o/o solution of DDT in diesel fuel. This corresponds approximately to 100 g of toxic chemical to linear meter in comparison with ~10 g/m for a generator of the type AG-UD-2. With the effective width of the grip/capture 7 km (death of the caterpillars of gipsy moth and pinewood beetle at this distance was 90-95o/o) the productivity of the machine ~7000 ha/h, and the norm of the consumption of toxic chemical of approximately 0.2 kg/ha instead of 1-1.5 kg/ha for AG-UD-2 [10].

The many-year experience of application/use of MAG in the different regions of Western Siberia and Urals showed that to inexpediently create the machine, having the width of the grip/capture of more than 10-20 km, since the width of the wood sections, strongly infected by harmful insects, as a rule, does not exceed the indicated value. At the same time maximum power of MAG double no longer is earlier. In separate experiments during

conducting official tests of MAG at power of approximately 300 l/min it was establish/installed that the death of the caterpillars of the gipsy moth of 4-6-go ages at a distance 15 km of the trajectory of generator was equal to 92o/o.

To similar conclusion/derivations it is possible to arrive, on the basis of other considerations. For example, in scaffolding/forest the average wave propagation velocity on the workable territory of approximately 1 m/s (3.6 km/h). Time of days, most favorable for conducting the processings (inversion), approximately from 22 to 5 h of the morning, i.e., 7 hours. Therefore under conditions of forest irrational to utilize generators with effective distance it is more than 25 km.

Use of a powerful aerosol wave, in the first place, makes it possible of using the aerosol method under conditions of the forest where is absent the dense grid/network of roads; in the second place, it decreases the norm of consumption; thirdly, because of the longer lifetime of cloud due to turbulent diffusion is led to alignment/levelling of initial heterogeneities, as a result of which toxic chemical more evenly is distributed on the workable territory (it is improved quality of finish). Reduction in the cost/value of processing (decrease in the norm of consumption) makes it possible to utilize this method for preventive target/purposes. Processing large

area for short time eliminates secondary population harmful insect because of them from the unfinished areas. Enormous productivity makes it possible to conduct fight within the extremely compressed periods, that are important when selecting of optimum conditions (the most vulnerable time for harmful insects, less dangerous periods for the useful entomological fauna).

Let us pass to the simplified quantitative description of the laws governing the distribution of highly dispersed aerosol cloud. In this case, mathematical calculations will be utilized only in that measure, how this is necessary for the explanation of numerical ratios. Primary attention let us focus on the physical essence of the phenomenon.

The process of the propagation of aerosol wave is determined by the laws governing turbulent diffusion. This phenomenon is very complicated and it is varied. Even within the framework of semi-empirical description [11] during the comparison of calculations with experimental data it is necessary to take into consideration change in time and in space and wind velocity and diffusion coefficients.

Page 8.

Is not less substantially the effect of the character of the underlying surface. To say nothing of about the fact that the measurement such of a quantity of parameters is completely unacceptable from the practical point, since when conducting of economic processings it is not possible to carry out the measurement of the large number of different characteristics by themselves these measurements become meaningless, since parameters enumerated above are very variable. It is logical therefore to attempt to simplify the calculation procedure, after isolating the most important characteristics, which yield to the simplest measurements.

For the calculation of a change in the dose with distance, we selected the model where coefficients of turbulent diffusion and wind velocity have the constant assigned/prescribed values. Measuring the dose at different distances from generator, and also the velocity of wind, it is possible, being given the coefficient of turbulent diffusion, to conduct the direct/straight comparison of computed values with experimental data. The coefficient of turbulent diffusion is found through measured wind velocity, since these parameters closely interconnected [11]. According to the degree of the conformity of experimental values calculated was decided the question concerning the suitability of this method of calculation in appendix to practical needs.

Let us examine distribution in the space of the concentration of aerosol as a result of the action of the instantaneous line source, arrange/located along the axis y. As we narrower indicated earlier, the particles of highly dispersed aerosol have low size/dimensions and their motion under the action of the force of gravity can be disregarded in comparison with the transfer as a result of turbulent diffusion. In this case the concentration of suspended matter in space at the different moment of time will be expressed by the formula

$$c = \frac{Q}{4\pi k t} e^{-\frac{x^2 + z^2}{4kt}} \quad (1)$$

and logically it does not depend on y.

Here k - the coefficient of turbulent diffusion in m²/s. Time t is counted off in seconds from the torque/moment of the generation of aerosol.

If source power Q is expressed in g/m, then concentration c will be expressed in g/m³. Under actual conditions the generation of aerosol occurs not simultaneously on entire line, while at the different moment of time, determined by the final rate of the displacement of generator. Therefore concentration distribution of aerosol in space during displacement along y axis is changed reasonably of dependence on time. Because of this will occur the flow

along y axis, somewhat distorting the picture of the distribution of the concentration of aerosol of equation (1). Essential diffusion exchange in time t occurs within the limits of the limited space $\pm\Delta y$, moreover $\Delta y$ it can be estimated from relationship/ratio $\Delta y \approx \sqrt{2kt}$. If difference in time t, equal to $\Delta t$ and corresponding to change $y$ then $y_0$ to $y_0+\Delta y$, is small as compared with time $t_0$, i.e., $\Delta t \ll t_0$, then the error, caused by neglect of a change in the concentration along $y$, axis, will be low. If the velocity of motion is equal to u, then $\Delta t = \frac{\Delta y}{u}$, and therefore $\Delta t \approx \frac{\sqrt{2kt_0}}{u}$. Thus, equation (1) can be used for the computation of the concentration of aerosol with good accuracy/precision under condition $\frac{\sqrt{2kt_0}}{u} \ll t_0$. At the velocity of the motion of the source several meters per second and with value of the coefficient of turbulent diffusion k on the order of 1 $m^2/s$ this condition are fulfilled with $t_0$ larger than several tens of seconds.

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The stricter solution of the problem of concentration distribution of aerosol in space for the generator, which is moved with final velocity, shows that for the real values of k the formula, which describes a change in the concentration of time for the source, which moves with final velocity, transfer/converts to equation (1) after after 5 s from the beginning of the work of generator.

Considerably more strongly manifests itself initial condition due to the finite dimension of the jet, which escape/ensues from generator. Since jet velocity decreases to the value of the order of several meters per second at a distance where the width of approximately 20 m on a radius, to use formula for a linear instantaneous source is possible after 100-200 s.

Keeping in mind concentration distribution of aerosol near the earth's surface when its generation occurs at a low altitude h, concentration in the same approach/approximation can be described by the equation

$$c = \frac{Q}{4\pi k t} e^{-\frac{x^2}{4kt}} \left[ e^{-\frac{(z-h)^2}{4kt}} + e^{-\frac{(z+h)^2}{4kt}} \right]. \qquad (2)$$

Concentration at ground level (with z = 0), obviously, will be equal to

$$c_0 = \frac{Q}{2\pi k t} e^{-\frac{x^2+h^2}{4kt}}. \qquad (3)$$

These equations can be extended to the driving downwind aerosol wave, examining it in the coordinates, which are moved together with it with wind velocity.

Let the aerosol wave be transferred by wind with velocity v (y - the trajectory of generator). Then for the computation of the concentration of aerosol at a distance of R from the line of

generator (way of generator) time t in equation (3) it is necessary to take t = R/v.

Maximum concentration at ground level at a distance of R (or, which is the same, at the moment of time, equal t), i.e., with x = 0, it will be equal to

$$c_m = \frac{Q}{2\pi k t} e^{-\frac{h^2}{4kt}} = \frac{Qv}{2\pi k R} e^{-\frac{h^2 v}{4kR}}. \qquad (4)$$

Maximum concentration at ground level with the same source power Q at height/altitude h, different from zero, is very low. At short distances from the line of the course of generator, it grows with an increase in distance R, it reaches the greatest value when $t_m = \left(\frac{R}{v}\right)_m = \frac{h^2}{4k}$ and it is decreased again. At large distances it falls inversely proportional to R.

As the example, which characterizes the biological effectiveness of aerosol wave, let us examine, as it is changed in the course of time and by distance dose, understanding hearth by it $\int c\,dt$, distributed all the time of the presence of aerosol at the particular point. Dose of the earth's surface

$$Д_0 = \int_{-\infty}^{\infty} c_0\,dt = \int_{-\infty}^{\infty} \frac{Q}{2\pi k t} e^{-\frac{h^2+x^2}{4kt}}\,dt.$$

If the torque/moment of the emergence of aerosol is equal sufficient to wide interval of time $t_0$, then it is possible without large error

to suppose that

$$Д_0 \approx Д_0' = \int_{-\infty}^{\infty} \frac{Q}{2\pi k t_0} e^{-\frac{h^2+x^2}{4kt_0}} dt.$$

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Then, replacing dx = vdt and integrating, we will obtain

$$Д_0 = \frac{Q}{2\pi k t_0} \frac{e^{-\frac{h^2}{4kt_0}}}{v} \int_{-\infty}^{\infty} e^{-\frac{x^2}{4kt_0}} dx = \frac{Q}{v\sqrt{\pi k t_0}} e^{-\frac{h^2}{4kt_0}}. \quad (5)$$

If we suck the air through the filter with constant velocity B ($l$/s), beginning with the torque/moment of the arrival of wave and ending with the torque/moment when aerosol wave passed, then on filter will settle a quantity of aerosol A(g). This quantity (let us call/name it sample/test), obviously, equally

$$A = \int_{-\infty}^{\infty} c_0 B\, dt = Д_0 B. \quad (6)$$

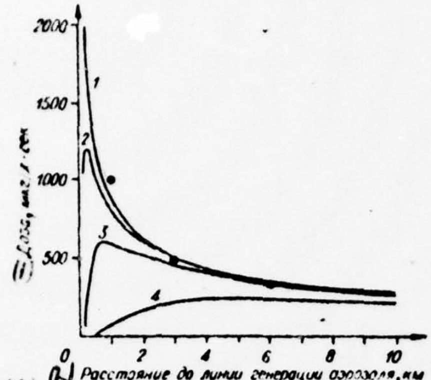
Thus, the which interests us value $D_0$ is equal to the quantity of deposited on filter toxic chemical, divided into the velocity of sampling. The value of dose can be expressed by distances from the line of the course of generator R. Replacing in equation (5) $t_0$ on R/v, we will obtain

$$Д_0 = \frac{Q}{\sqrt{\pi k R v}} e^{-\frac{h^2 v}{4kR}}. \quad (7)$$

The values of the doses, given by relationship/ratio (7) for different distances from the trajectory of generator, are given in

figure.

From the examination of figure, it is evident that the greatest changes in the value of dose are observed at small distance from generator. So, the small flotation of aerosol wave because of the initial superheating of cloud causes a considerable change in the dose. Hence it is clear that the experiments, conducted on the small generator when the determination of a quantity of toxic chemical is produced at distances into several hundreds of meters, do not make it possible to establish/install any quantitative laws. With an increase in the distance, the effect of initial flotation manifests itself increasingly less. For example, change in altitude of flotation to 50 m is narrower from distance 3 km and further it leads to a change in the dose not more than two times, which is within the limits at present of possible experimental spread. The most important consequence of the established/installed laws for the practical use of an aerosol method directly follows from the law of a change in the dose with distance. In the case of ground-based source, or beginning from the listance where the elevation of source is unessential, the decrease of dose with distance is subordinated to dependence $\frac{Q_{const}}{\sqrt{R}}$. This indicates that if it is necessary to create the zone within limits of which the dose must be more than certain $Д_{эфф}$, then with an increase in the power double the width of the effectiveness of processing increases four times. In summation, the specific consumption is decreased double.




Key: (1). Dose, μg/l•s. (2). Distance of the line of the generation of aerosol, km. (3). h = 0 (1); 10 (2); 20 (3); 50 m (4); k - 1 m²/s; v = 4 m/s; Q = 100 g/m.

Page 11.

It was previously indicated that the use of a diagram of the calculation of the dose where the wind velocity and the coefficient of turbulent diffusion were constant, possibly, if the experimental values of doses are located in accordance with those who were calculated. Therefore during production tests of MAG were measured doses at different distance/removals from generator. Those who were obtained as a result of these measurements of the value of doses were used for testing of the suitability of the taken model.

Points in the figure plotted/applied the maximum values of the doses, measured under field conditions at different distance/removals from the trajectory of powerful aerosol generator. Curve 1 gives the maximum possible values of dose when source is located near from the earth/ground. Under actual conditions the escape/ensuing from generator jet of hot gas has excess temperature in comparison with surrounding air. Therefore depending on external meteorological conditions, aerosol cloud can float because of Archimedes forces.

There is at present neither no experimental material nor the theoretical relationship/ratios which would make it possible to sufficiently accurately and reliably determine the height/altitude of the flotation of cloud. But when the height/altitude of flotation is low, we they must obtain the doses, close to values, given by curve 1. As can be seen from figure, experimental points will agree well with the designed dependence.

Thus, for practical needs the estimate of the magnitude of dose and character of its change with distance depending on wind velocity and coefficient of turbulent diffusion (it is selected in accordance with measured wind velocity, is taken its average value for the characteristic conditions of conducting experiment) can be made, if are known the power of generator and the height/altitude of the ejection above the earth's surface.

From the results of observations conducted at the IKhKiG of the AS USSR, at the power of generator 100 g/m, highly dispersed aerosol cloud was led to the death of 90-95o/o caterpillars of gipsy moth and pinewood beetle at distances to 5-7 km [8, 9]. At distances from 1 to 7 km, the dose is changed within limits from 900 to 250 μg/l•s, if the height/altitude of ejection is not more than 20 m. Evidently, dose 250 μg/l•s is close to the lethal dose of highly dispersed aerosols for insects enumerated earlier. For a generator of type AG-UD-2, power is close to 10 g/m, i.e., 10 times, it is less. If wave from AG-UD-2 surfaces under the action of Archimedes forces on height/altitude 10 m or more, then maximum dose will be equal to 120 μg/l•s. This follows from the proportionality of the dose of the power of generator (for MAG maximum dose with h = 10 m it is equal to 1200 μg/l•s). But this dose is less than the dose of the highly dispersed aerosols, which ensure sufficient death of harmful insects despite the fact that the specific consumption during testing of AG-UD-2 is more 5-7 times, than in the case of application/use of MAG. This it suggests, that the effectiveness of small aerosol generators most is probably determined by the presence of the considerable portion of the large unevaporated particles, but therefore small aerosol generators using the method of action are nearer to light-droplet sprayers than to the generators of

condensation aerosol.

After feeding sum to entire presented above, we come to following conclusions. A change in the dispersed composition significantly changes the character of the action: with aerial spraying and aerial dusting (large particles) - permanent action, during the use of highly dispersed aerosols (small particle) - acute/sharp action. For the possibility of effective fight with harmful insects, the generators of highly dispersed aerosols must have large power. The application/use of generators of the highly dispersed aerosols of large power makes it possible to decrease the norm of the consumption of toxic chemical, considerably decreasing the cost/value of processing and improving sanitary-hygienic conditions.

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When conducting of practical calculations of the doses of highly dispersed aerosols, it is possible to set/assume wind velocity and the coefficients of turbulent diffusion by constants under the selected conditions.

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1. Я. В. Пейве, А. В. Петербургский. Химия в сельском хозяйстве. «Колос», 1964
2. Н. Г. Берим. Химическая защита растений. «Колос», 1966.
3. Д. Ф. Рудиев. Химические средства в борьбе с вредителями леса. «Лесная промышленность», 1966.
4. Применение аэрозолей в сельском хозяйстве. Сб. переводов под ред. А. Г. Амелина. Изд-во иностр. лит., 1955.
5. Аэрозоли в сельском хозяйстве. Сб. статей под ред. А. Г. Амелина, В. Ф. Дунского, Г. Н. Коротких. Сельхозгиз, 1956.
6. Аэрозоли и их применение. Тр. II и III Междунар. совещ. по аэрозолям при ВАСХНИЛ. Под ред. А. Г. Амелина. Сельхозгиз, 1959.
7. Г. Н. Коротких. Аэрозоли в растениеводстве. «Колос», 1967.
8. С. Н. Берденникова, Н. Н. Жирнова, С. Н. Новиков, Е. Н. Киров, В. Р. Никитина. Защита растений от вредителей и болезней (1964), № 11, 28.
9. С. Н. Берденникова, Н. Н. Жирнова, А. А. Ковальский. Химические средства защиты растений (1966), № 6, 14.
10. Н. Н. Жирнова, Г. Н. Загуляев, А. А. Ковальский, С. Н. Новиков, Ю. Н. Рыков, В. М. Сахаров. Материалы (тезисы) Всесоюзной научно-технич. конф. по применению аэрозолей в народном хозяйстве (14—17 марта 1967 г.). М., 1967, стр. 196.
11. А. С. Монин, А. М. Яглом. Статистическая гидромеханика, ч. I. М., «Наука», 1965.

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## THE PHYSICO-CHEMICAL FOUNDATIONS OF THE APPLICATION OF HIGH-DISPERSED AEROSOLS FOR PEST CONTROL

The features of the application of high-dispersed aerosols for pest control is discussed. The advantages of this pest control method was shown. The concept "dose" (the integral of concentration over time) is used to explain the redution of specific expense of insecticide with the application of a poweful aerosol generator.

Supposing the coefficient of the turbulent diffusion and wind are constant, the dose at various distances from the aerosol generator was calculeted. The dose was also measured in the field experiments. The experimental data are in accordance with calculate.

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